

What is claimed is:

1. A projection-type display device, comprising at least:

a first reflection-type image-forming means for  
5 spatially modulating and reflecting an incident first illumination light to emit a first optical image,

a second reflection-type image-forming means for spatially modulating and reflecting an incident second illumination light to emit a second optical image,

10 a wavelength separation mirror for reflecting illumination light of a predetermined wavelength in incident light and emitting it as said first illumination light to said first reflection-type image-forming means and transmitting the remaining illumination light and  
15 emitting it as said second illumination light to said second reflection-type image-forming means so as to reflect said first optical image and transmit said second optical image and emit said first and second optical images so as to follow the optical path of said incident  
20 light in reverse,

a projection optical system for projecting said first and second optical images,

a light source for emitting predetermined light to said wavelength separation mirror as said incident  
25 light, and

a light separating means for emitting said incident light emitted from said light source to said wavelength separation mirror and emitting the first and second optical images incident from said wavelength separation mirror to said projection optical image,

the inclination of the wavelength separation mirror set so that the optical axis of the light incident on the wavelength separation mirror and the optical axis of the first optical image becomes smaller than 90 degrees.

2. A projection-type display device as set forth in claim 1, wherein:

said first reflection-type image-forming means emits said first optical image with a plane polarization rotated with respect to the incident light and

a polarization filter for selectively transmitting illumination light of a plane polarization corresponding to the plane polarization of said light incident on said first reflection-type image-forming means is arranged between said light source and said light separating means.

3. A projection-type display device as set forth in claim 1, wherein

said first reflection-type image-forming means emits said first optical image with a plane polarization

rotated with respect to the incident light and

a polarization filter for selectively  
transmitting incident light of a plane polarization  
corresponding to the plane polarization of said first  
5 optical image is arranged between said projection optical  
system and said light separating means.

4. A projection-type display device as set forth  
in claim 1, wherein

said first reflection-type image-forming means  
10 emits said first optical image with a plane polarization  
rotated with respect to the incident light,

a first polarization filter for selectively  
transmitting illumination light of a plane polarization  
corresponding to the plane polarization of said light  
15 incident on said first reflection-type image-forming  
means is arranged between said light source and said  
light separating means, and

a second polarization filter for selectively  
transmitting incident light of a plane polarization  
20 corresponding to the plane polarization of said first  
optical image is arranged between said projection optical  
system and said light separating means.

5. A projection-type display device, comprising at  
least:

25 a first reflection-type image-forming means for

spatially modulating and reflecting an incident first illumination light to emit a first optical image,

a second reflection-type image-forming means for spatially modulating and reflecting an incident

5 second illumination light to emit a second optical image,

a third reflection-type image-forming means for spatially modulating and reflecting an incident third illumination light to emit a third optical image,

a first wavelength separation mirror for  
10 reflecting illumination light of a predetermined wavelength in incident light and emitting it as said first illumination light to said first reflection-type image-forming means and transmitting and emitting the remaining illumination light so as to reflect said first  
15 optical image and transmit said second and third optical images and emit said first, second, and third optical images so as to follow the optical path of the incident light in reverse,

a second wavelength separation mirror for  
20 reflecting illumination light of a predetermined wavelength in light transmitted through said first wavelength separation mirror and emitting it as said second illumination light to said second reflection-type image-forming means and transmitting the remaining  
25 illumination light and emitting it as said third

illumination light to said third reflection-type image-forming means so as to reflect said second optical image and transmit said third optical image and emit said second and third optical images toward said first  
5 wavelength separation mirror,

a projection optical system for projecting said first, second, and third optical images,

a light source for emitting predetermined light to said first wavelength separation mirror as said  
10 incident light, and

a light separating means for emitting said incident light emitted from said light source to said first wavelength separation mirror and emitting the first, second, and third optical images incident from  
15 said first wavelength separation mirror to said projection optical image,

the inclination of said first wavelength separation mirror set so that the optical axis of the light incident on said first wavelength separation mirror  
20 and the optical axis of said first optical image becomes smaller than 90 degrees,

the inclination of said second wavelength separation mirror set so that the optical axis of the light incident on said second wavelength separation  
25 mirror and passing through said first wavelength

separation mirror and the optical axis of said second optical image becomes smaller than 90 degrees.

6. A projection-type display device as set forth in claim 5, wherein:

5           said first reflection-type image-forming means emits said first optical image with a plane polarization rotated with respect to the incident light and

          a polarization filter for selectively  
transmitting illumination light of a plane polarization  
10   corresponding to the plane polarization of said light  
incident on said first reflection-type image-forming  
means is arranged between said light source and said  
light separating means.

7. A projection-type display device as set forth  
15   in claim 5, wherein

          said first reflection-type image-forming means emits said first optical image with a plane polarization rotated with respect to the incident light and

          a polarization filter for selectively  
20   transmitting incident light of a plane polarization  
corresponding to the plane polarization of said first  
optical image is arranged between said projection optical  
system and said light separating means.

8. A projection-type display device as set forth  
25   in claim 5, wherein

said first reflection-type image-forming means emits said first optical image with a plane polarization rotated with respect to the incident light,

5 a first polarization filter for selectively transmitting illumination light of a plane polarization corresponding to the plane polarization of said light incident on said first reflection-type image-forming means is arranged between said light source and said light separating means, and

10 a second polarization filter for selectively transmitting incident light of a plane polarization corresponding to the plane polarization of said first optical image is arranged between said projection optical system and said light separating means.

15 9. A projection-type display device, comprising:  
a reflection-type image-forming means for spatially modulating and reflecting illumination light of a predetermined plane polarization to emit an optical image with a plane polarization rotated with respect to  
20 the plane polarization of the illumination light,

a projection optical system for projecting said optical image,

a light source for emitting said illumination light, and

25 a light separating means for emitting said

illumination light emitted from said light source toward  
said reflection-type image-forming means and emitting  
said optical image emitted from said reflection-type  
image-forming means to said projection optical system,

5                   a polarization separation element for  
selectively transmitting illumination light of a plane  
polarization corresponding to the plane polarization of  
the light incident on said reflection-type image-forming  
means and selectively reflecting the component of the  
10 plane polarization orthogonal to that plane polarization  
arranged between said light source and said light  
separating means.

10. A projection-type display device as set forth  
in claim 9, wherein said polarization separation element  
15 is formed on an incident facet of the illumination light  
of said light separating means.

11. A projection-type display device, comprising:  
a reflection-type image-forming means for  
spatially modulating and reflecting illumination light of  
20 a predetermined plane polarization to emit an optical  
image with a plane polarization rotated with respect to  
the plane polarization of the illumination light,  
a projection optical system for projecting said  
optical image,  
25 a light source for emitting said illumination



light, and

a light separating means for emitting said illumination light emitted from said light source toward said reflection-type image-forming means and emitting  
5 said optical image emitted from said reflection-type image-forming means to said projection optical system,

a polarization separation element for selectively transmitting incident light of a predetermined plane polarization corresponding to the  
10 plane polarization of said optical image and selectively reflecting the component of the plane polarization orthogonal to that plane polarization arranged between said projection optical system and said light separating means.

15 12. A projection-type display device as set forth in claim 11, wherein said polarization separation element is formed on an emission facet of the optical image of said light separating means.

13. A projection-type display device, comprising:  
20 a reflection-type image-forming means for spatially modulating and reflecting illumination light of a predetermined plane polarization to emit an optical image with a plane polarization rotated with respect to the plane polarization of the illumination light,

25 a projection optical system for projecting said

optical image,

a light source for emitting said illumination light, and

a light separating means for emitting said  
5 illumination light emitted from said light source toward  
said reflection-type image-forming means and emitting  
said optical image emitted from said reflection-type  
image-forming means to said projection optical system,

a first polarization separation element for  
10 selectively transmitting illumination light of a plane  
polarization corresponding to the plane polarization of  
the light incident on said reflection-type image-forming  
means and selectively reflecting the component of the  
plane polarization orthogonal to that plane polarization  
15 arranged between said light source and said light  
separating means,

a second polarization separation element for  
selectively transmitting incident light of a  
predetermined plane polarization corresponding to the  
20 plane polarization of said optical image and selectively  
reflecting the component of the plane polarization  
orthogonal to that plane polarization arranged between  
said projection optical system and said light separating  
means.

25 14. A projection-type display device as set forth

in claim 13, wherein said first polarization separation element is formed on an incident facet of the illumination light of said light separating means.

15 15. A projection-type display device as set forth in claim 13, wherein said second polarization separation element is formed on an emission facet of the optical image of said light separating means.

16. A projection-type display device as set forth in claim 13, wherein  
10 said first polarization separation element is formed on an incident facet of the illumination light of said light separating means, and

said second polarization separation element is formed on an emission facet of the optical image of said  
15 light separating means.

17. A projection-type display device, comprising:  
a reflection-type image-forming means for spatially modulating illumination light of a predetermined plane polarization to emit an optical image  
20 with a plane polarization rotated with respect to the plane polarization of the illumination light,

a projection optical system for projecting said optical image,

a light source for emitting said illumination  
25 light, and

a polarization beam splitter for emitting said illumination light emitted from said light source toward said reflection-type image-forming means and emitting a predetermined polarization component in the optical light  
5 incident from said reflection-type image-forming means to said projection optical system,

said polarization beam splitter being formed by a member satisfying the following relationship:

10 
$$5.00 \times 10^2 \geq K \cdot \alpha \cdot E \cdot \frac{C_p}{\rho} \int_{\lambda_2}^{\lambda_1} (1-T) d\lambda$$

where, K: photoelasticity constant of said member  
(nm/mm·mm<sup>2</sup>/N),

$\alpha$ : linear ~~expansion~~ coefficient of said member  
(10<sup>-6</sup>/K),

15 E: Young's modulus of said member (10<sup>3</sup>N/mm<sup>2</sup>),

$\lambda$ : wavelength of the illumination light (nm),

T: internal transmittance of said member at the wavelength  $\lambda$ ,

$\rho$ : specific gravity of said member (g/cm<sup>3</sup>), and

20  $C_p$ : specific heat of said member (J/g·K),

the integration range in Equation being a range of the light absorption wavelength band of the member.

18. A projection-type display device as set forth in claim 17, wherein said light absorption wavelength

band is a range of 420 nm to 500 nm.

19. A projection-type display device as set forth  
in claim 17, wherein a polarization separation element  
for selectively transmitting illumination light of a  
5 plane polarization corresponding to the plane  
polarization of the light incident on said reflection-  
type image-forming means and selectively reflecting the  
component of the plane polarization orthogonal to that  
plane polarization arranged between said light source and  
10 said polarization beam splitter.

20. A projection-type display device as set forth  
in claim 19, wherein said polarization separation element  
is formed on an incident facet of the illumination light  
of said polarization beam splitter.

15 21. A ~~projection~~-type display device as set forth  
in claim 17, wherein a polarization separation element  
for selectively transmitting incident light of a  
predetermined plane polarization corresponding to the  
plane polarization of said optical image and selectively  
20 reflecting the component of the plane polarization  
orthogonal to that plane polarization arranged between  
said projection optical system and said polarization beam  
splitter.

22. A projection-type display device as set forth  
25 in claim 21, wherein

said polarization separation element is formed on an emission facet of the optical image of said polarization beam splitter.

23. A projection-type display device as set forth  
5 in claim 17, wherein

a first polarization separation element for selectively transmitting illumination light of a plane polarization corresponding to the plane polarization of the light incident on said reflection-type image-forming  
10 means and selectively reflecting the component of the plane polarization orthogonal to that plane polarization arranged between said light source and said polarization beam splitter and /

a second polarization separation element for  
15 selectively transmitting incident light of a predetermined plane polarization corresponding to the plane polarization of said optical image and selectively reflecting the component of the plane polarization orthogonal to that plane polarization arranged between  
20 said projection optical system and said polarization beam splitter.

24. A projection-type display device as set forth in claim 23, wherein said first polarization separation element formed on to an incident facet of the  
25 illumination light of said polarization beam splitter.

25. A projection-type display device as set forth in claim 23, wherein said second polarization separation element is formed on an emission facet of the optical image of said polarization beam splitter.

5        26. A projection-type display device as set forth in claim 23, wherein

        said first polarization separation element is formed on an incident facet of the illumination light of said polarization beam splitter and

10        said second polarization separation element is formed on an emission facet of the optical image of said polarization beam splitter.

27. A projection-type display device, comprising:

        a plurality of reflection-type image-forming  
15 means each of which ~~for~~ spatially modulating incident light of a predetermined wavelength and emitting an optical image with a plane polarization rotated with respect to the plane polarization of the incident light,  
        a light source for emitting illumination light,  
20        a dichroic prism for emitting illumination light emitted from said light source to said plurality of reflection-type image-forming means based on wavelength and emitting said optical images incident from said plurality of reflection-type image-forming means so as to  
25 run in reverse along the optical axis of said

illumination light,

a projection optical system for projecting said optical images, and

a polarization beam splitter for emitting said  
5 illumination light emitted from said light source toward said dichroic prism and emitting a predetermined polarization component in said optical images incident from said dichroic prism to said projection optical system,

10 said polarization beam splitter and/or said dichroic prism being formed by a member satisfying the following relationship:

$$5.90 \times 10^2 \geq K \cdot \alpha \cdot E \cdot \frac{C_p}{\rho} \int_{\lambda_2}^{\lambda_1} (1-T) d\lambda$$

15 where, K: photoelasticity constant of said member (nm/mm·mm<sup>2</sup>/N),

$\alpha$ : linear expansion coefficient of said member (10<sup>-6</sup>/K),

E: Young's modulus of said member (10<sup>3</sup>N/mm<sup>2</sup>),

20  $\lambda$ : wavelength of the illumination light (nm),

T: internal transmittance of said member at the wavelength  $\lambda$ ,

$\rho$ : specific gravity of said member (g/cm<sup>3</sup>), and

C<sub>p</sub>: specific heat of said member (J/g·K),



the integration range in Equation being a range of the light absorption wavelength band of the member.

28. A projection-type display device as set forth in claim 27, wherein said light absorption wavelength  
5 band is a range of 420 nm to 500 nm.

29. A projection-type display device as set forth in claim 27, wherein a polarization separation element for selectively transmitting illumination light of a plane polarization corresponding to the plane  
10 polarization of the light incident on said reflection-type image-forming means and selectively reflecting the component of the plane polarization orthogonal to that plane polarization arranged between said light source and said polarization beam splitter.

15 30. A projection-type display device as set forth in claim 29, wherein said polarization separation element is formed on an incident facet of the illumination light of said polarization beam splitter.

31. A projection-type display device as set forth  
20 in claim 27, wherein a polarization separation element for selectively transmitting incident light of a predetermined plane polarization corresponding to the plane polarization of said optical image and selectively reflecting the component of the plane polarization  
25 orthogonal to that plane polarization arranged between

said projection optical system and said polarization beam splitter.

32. A projection-type display device as set forth in claim 31, wherein

5           said polarization separation element is formed on an emission facet of the optical image of said polarization beam splitter.

33. A projection-type display device as set forth in claim 27, wherein

10           a first polarization separation element for selectively transmitting illumination light of a plane polarization corresponding to the plane polarization of the light incident on said reflection-type image-forming means and selectively reflecting the component of the  
15 plane polarization orthogonal to that plane polarization arranged between said light source and said polarization beam splitter and

          a second polarization separation element for selectively transmitting incident light of a  
20 predetermined plane polarization corresponding to the plane polarization of said optical image and selectively reflecting the component of the plane polarization orthogonal to that plane polarization arranged between said projection optical system and said polarization beam  
25 splitter.

34. A projection-type display device as set forth in claim 33, wherein said first polarization separation element is formed on an incident facet of the illumination light of said polarization beam splitter.

5        35. A projection-type display device as set forth in claim 33, wherein said second polarization separation element is formed on an emission facet of the optical image of said polarization beam splitter.

36. A projection-type display device as set forth  
10 in claim 33, wherein

      said ~~first~~ polarization separation element is formed on an incident facet of the illumination light of said polarization beam splitter and

      said second polarization separation element is  
15 formed on an emission facet of the optical image of said polarization beam splitter.